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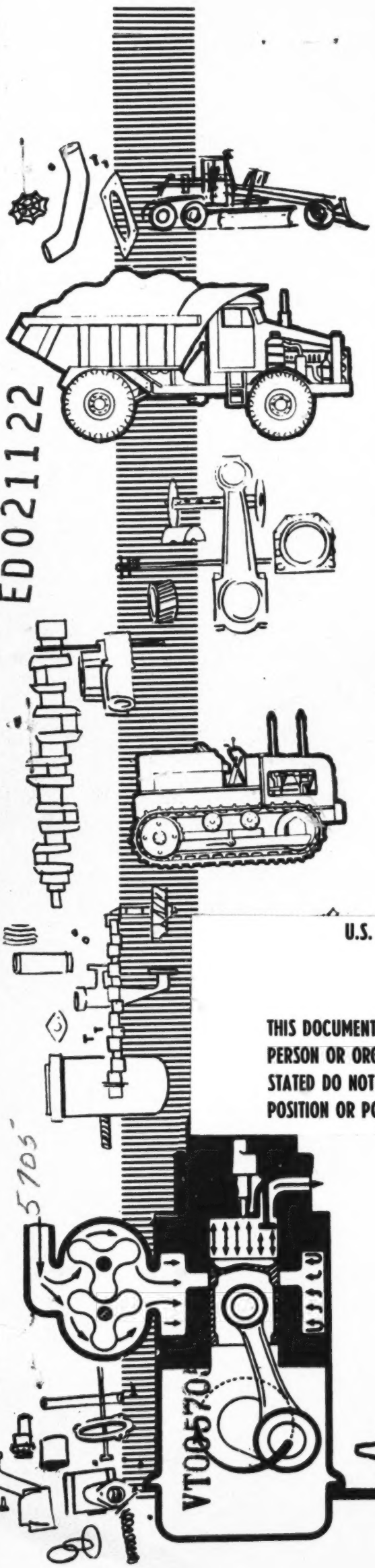
AUTOMOTIVE DIESEL MAINTENANCE 2. UNIT XXI, MICHIGAN/CLARK TRANSMISSION--COMPLETE POWER TRAIN.

HUMAN ENGINEERING INSTITUTE, CLEVELAND, OHIO
REPORT NUMBER AM-2-21 PUB DATE 22 SEP 67
MINNESOTA STATE DEPT. OF EDUCATION, ST. PAUL
EDRS PRICE MF-$0.25 HC-$1.32 31P.

DESCRIPTORS- *STUDY GUIDES, *TEACHING GUIDES, *TRADE AND INDUSTRIAL EDUCATION, *AUTO MECHANICS (OCCUPATION), KINETICS, MOTOR VEHICLES, ADULT VOCATIONAL EDUCATION, DIESEL ENGINES, TRANSPARENCIES, PROGRAMED MATERIALS, INDIVIDUAL INSTRUCTION, INSTRUCTIONAL FILMS, PROGRAMED INSTRUCTION, *EQUIPMENT MAINTENANCE,

THIS MOSULE OF A 25-MODULE COURSE IS DESIGNED TO DEVELOP AN UNDERSTANDING OF A SPECIFIC POWER TRAIN SYSTEM USED ON DIESEL POWERED EQUIPMENT. TOPICS ARE EXAMINING THE POWER FLOW, UNIT OIL FLOW, AND OIL PRESSURE IN THE CONVERTER AND TRANSMISSION SYSTEM. THE MODULE CONSISTS OF A SELF-INSTRUCTIONAL PROGRAM TRAINING FILM "UNDERSTANDING THE MICHIGAN/CLARK POWER TRAIN" AND OTHER MATERIALS. SEE VT 005 685 FOR FURTHER INFORMATION. MODULES IN THIS SERIES ARE AVAILABLE AS VT 005 685 - VT 005 709. MODULES FOR "AUTOMOTIVE DIESEL MAINTENANCE 1" ARE AVAILABLE AS VT 005 655 - VT 005 684. THE 2-YEAR PROGRAM OUTLINE FOR "AUTOMOTIVE DIESEL MAINTENANCE 1 AND 2" IS AVAILABLE AS VT 006 006. THE TEXT MATERIAL, TRANSPARENCIES, PROGRAMED TRAINING FILM, AND THE ELECTRONIC TUTOR MAY BE RENTED (FOR $1.75 PER WEEK) OR PURCHASED FROM THE HUMAN ENGINEERING INSTITUTE, HEADQUARTERS AND DEVELOPMENT CENTER, 2341 CARNEGIE AVENUE, CLEVELAND, OHIO 44115. (HC)



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STUDY AND READING MATERIALS

AUTOMOTIVE DIESEL MAINTENANCE 2

MICHIGAN/CLARK TRANSMISSION --
COMPLETE POWER TRAIN UNIT XXI

SECTION A EXAMINING THE POWER FLOW

SECTION B UNIT OIL FLOW

SECTION C OIL PRESSURE IN THE CONVERTER AND TRANSMISSION SYSTEM

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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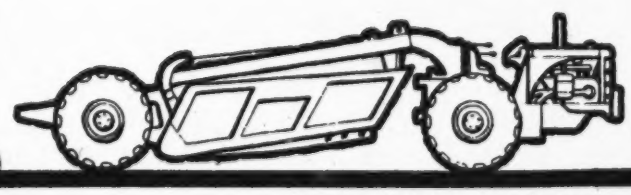

This is the first in a series of ten units discussing the Michigan/Clark Transmission and Converter. This combination is used in many types of vehicles, including one with which you may be familiar -- the Michigan/Clark rubber tired tractor dozer.

SECTION A -- EXAMINING THE POWER FLOW

Twisting power from the diesel engine is transmitted through a torque converter with a 3.0 to 1 torque multiplication factor, to a power shifted, eight speed forward, four speed reverse type transmission, and to the axle assemblies. See Figure 1. Note that the big difference between this arrangement and the Allison transmission is that the converter is separated from the transmission.

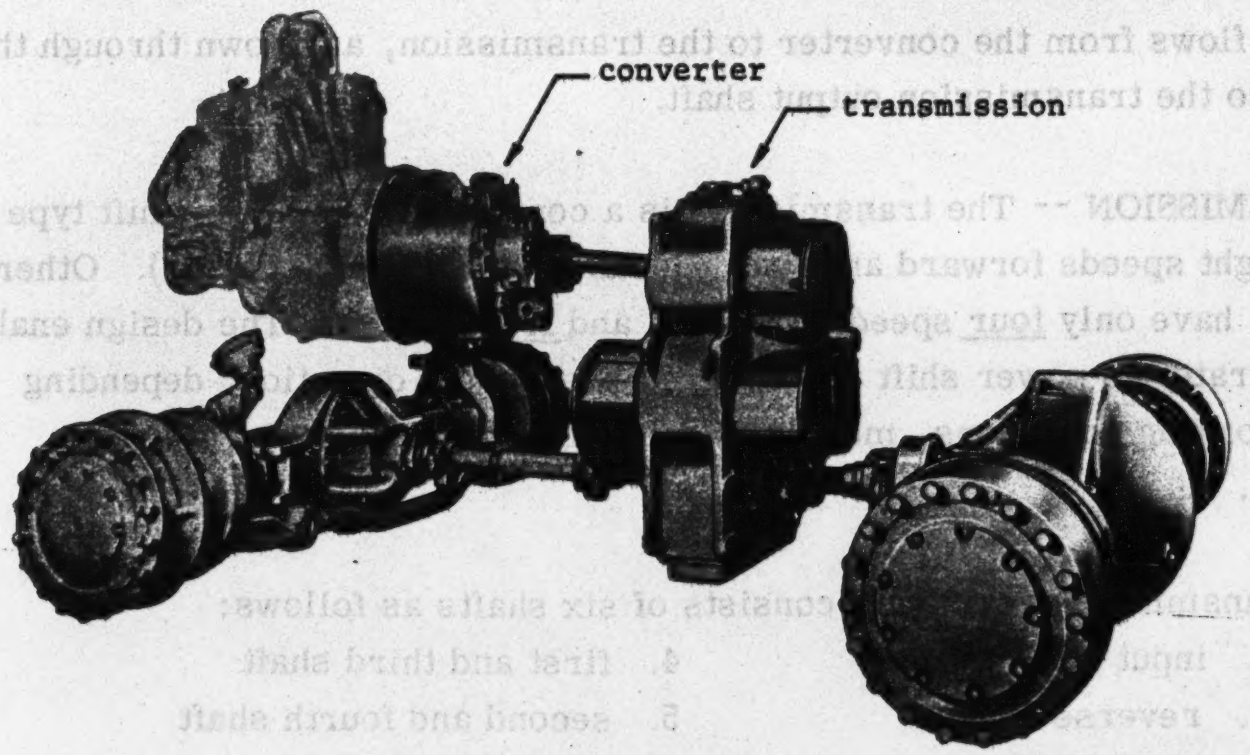

Fig. 1 Tractor dozer power train components

CONVERTER -- As we learned in the Allison units, the torque converter accepts rotating mechanical energy (from the engine), converts it to hydraulic energy, and then back to mechanical force or torque.

The converter is composed of four members: the pump, which is the driving member; the turbine, which is the driven member; the reaction member, which is splined on a fixed support; and the drive disc, which couples the converter to the engine. The pump and drive disc members form the outer shell. The turbine runs within the outer shell and is connected to the output shaft. The oil is the only connection between the turbine and pump members.

The reaction member is splined to the converter support, which is fixed and does not rotate in either direction. A gear is splined to the pump hub and drives through gears rotating the hydraulic pumps, mounted on the converter housing cover.

Power flows from the converter to the transmission, and down through the gears to the transmission output shaft.

TRANSMISSION -- The transmission is a constant mesh power shift type with eight speeds forward and four speeds reverse (16000 Series). Other models have only four speeds forward, and four reverse. The design enables the operator to power shift into desired speeds and direction, depending upon working conditions, merely by moving the levers on the steering column.

The transmission gear train consists of six shafts as follows:

1. input shaft
2. reverse shaft
3. idler shaft
4. first and third shaft
5. second and fourth shaft
6. output shaft

A screen, mounted in a frame, is positioned on the bottom of the transmission case, and screens out any foreign material. This screen is covered by the sump pan which is provided with magnets that catch any metallic particles.

Power from the transmission output shaft is transferred to the axle ring gears and pinion, and flows out to the planetaries which are located on the outer ends of the axles and which apply driving force to the wheels.

SECTION B -- UNIT OIL FLOW

During the following paragraphs, refer to Figure 2. This schematic shows oil flow through the transmission control cover and, also, to the converter and cooler assemblies.

With the engine running, the converter charging pump draws oil from the transmission sump and directs it first through filters, and then to the control cover mounted on top of the transmission case.

The oil is directed into the control cover at location "B" and through the regulating valve to the clutches.

After the clutches are supplied with oil, the regulating valve spool moves toward the spring until a port is exposed along the side of the bore. This allows the oil to flow through the port to the converter.

After entering the converter at "C", the oil is directed through the stator support to the converter cavity, and exits between the turbine shaft and converter support. The oil then passes through an oil distributor which directs the oil out of the converter by way of a downstream regulating valve, and out to the cooler.

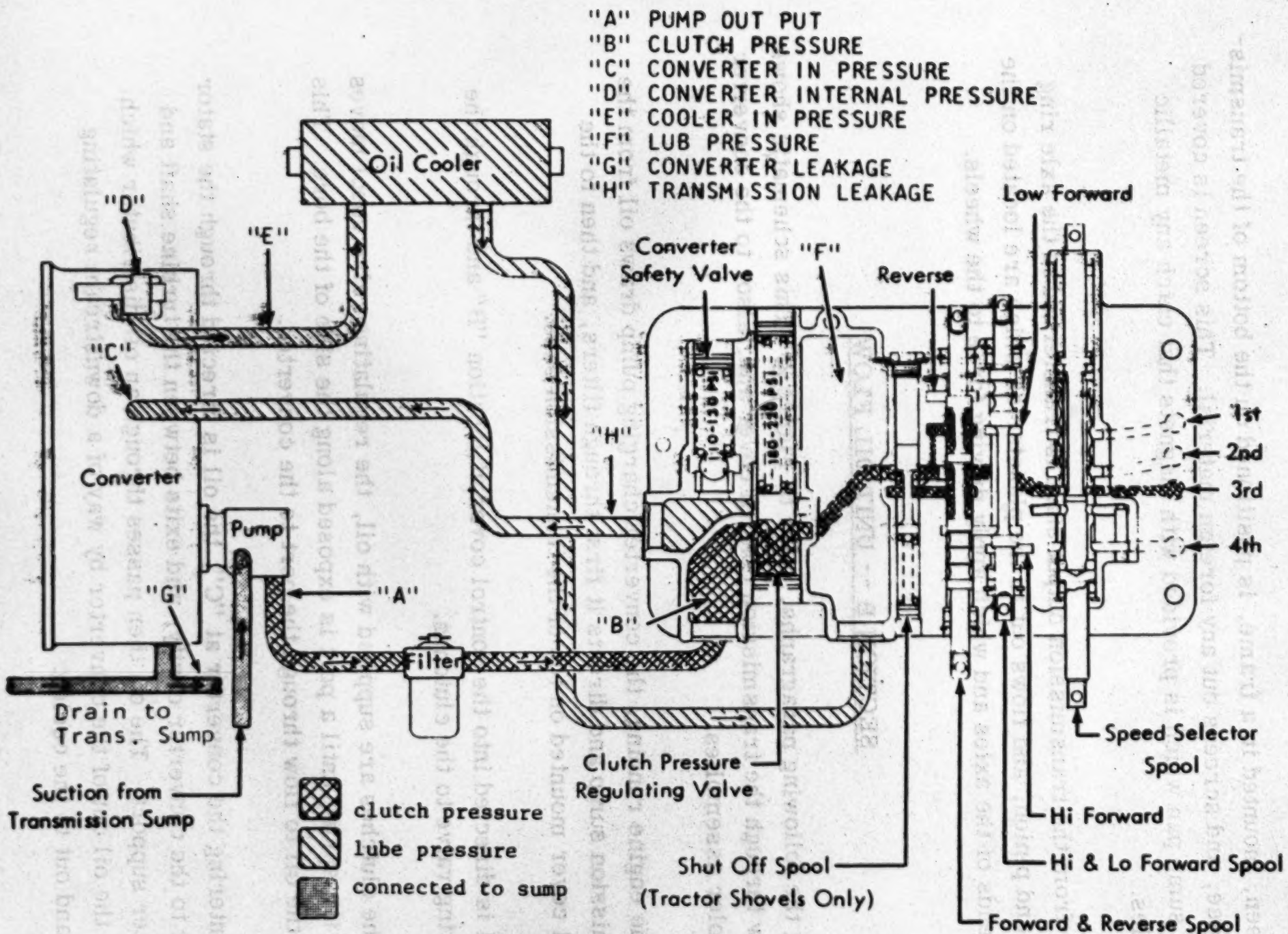

Fig. 2 Transmission control internal oil flow

After leaving the cooler, the oil is directed through a hose to the lubricating oil inlet on the transmission, and through a series of tubes to the transmission, bearings and clutches. The oil then returns to the transmission sump.

Figure 3 shows the external oil flow to the pump, transmission, converter, cooler, and, the return to the transmission sump. NOTE: The letters indicate the check points for the use of gauges and flow meters when troubleshooting.

The oil level in the transmission and converter system should be checked daily or at the completion of each shift. The engine must be running at low idle and the oil must be at operating temperature. A dipstick is provided to check the oil level in the transmission.

VOLUME FLOW -- For the following discussion, refer to Figure 4. Oil volume flow through the converter and transmission system is shown as follows:

Pump capacity is	31 gpm @ 2000 rpm
Transmission leakage	-2 gpm
Flow to converter	29 gpm @ 2000 rpm
Converter lube oil drain	-3 gpm
Flow through cooler	26 gpm return to transmission sump

The converter pump, mounted on the rear face of the converter housing, always turns at engine speed (like the Allison oil supply pump). The pump is a gear type and has a capacity of 31 gpm @ 2000 rpm.

With the engine running at 2000 rpm, the pump picks up 31 gallons of oil from the transmission sump, and directs it through filters, and then to the transmission control cover. Notice in Figure 4 that the oil is filtered before it enters the transmission and converter system. After filtering, oil enters the transmission control cover, and flows through a regulating

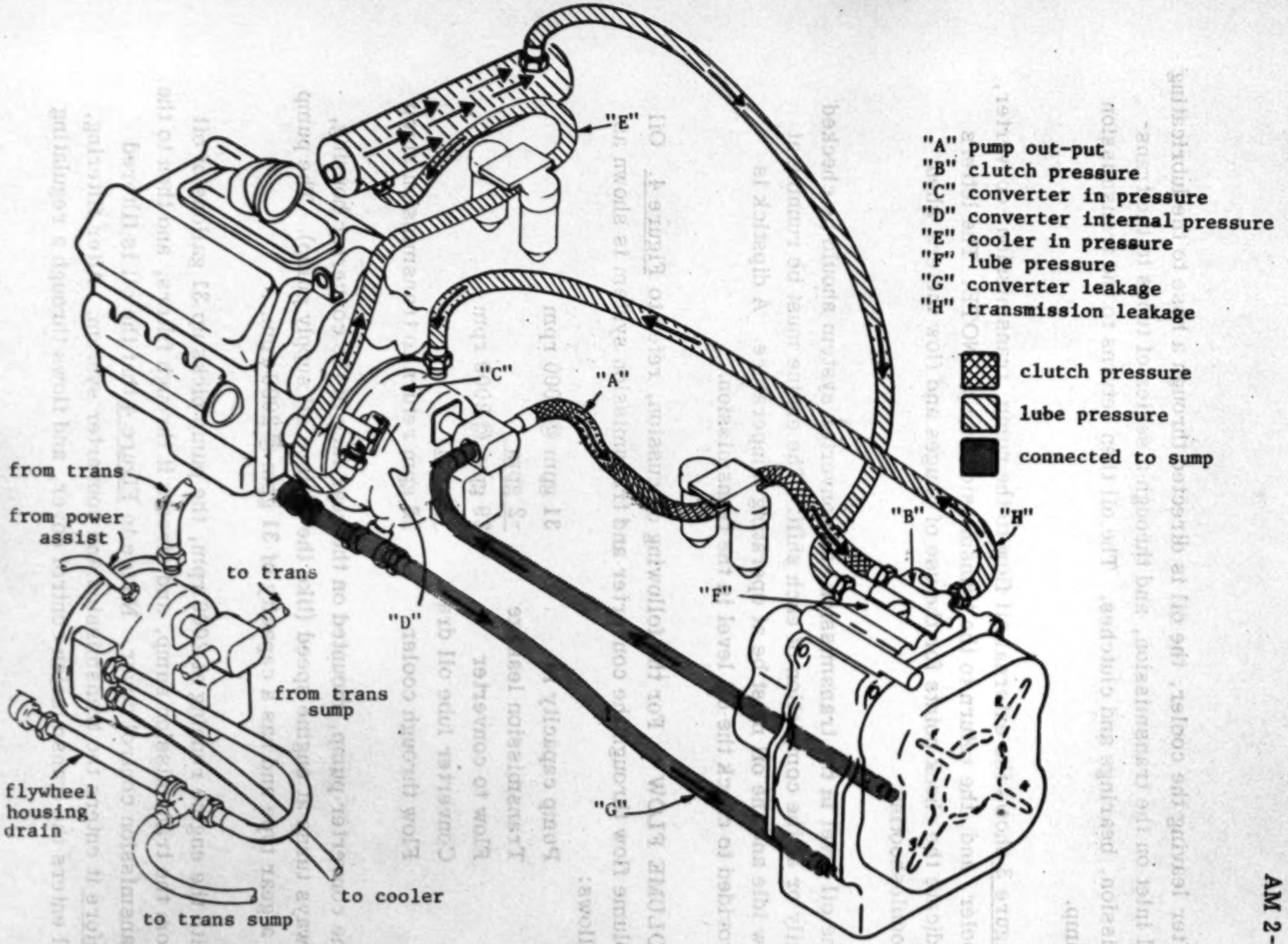

Fig. 3 Oil flow to each component

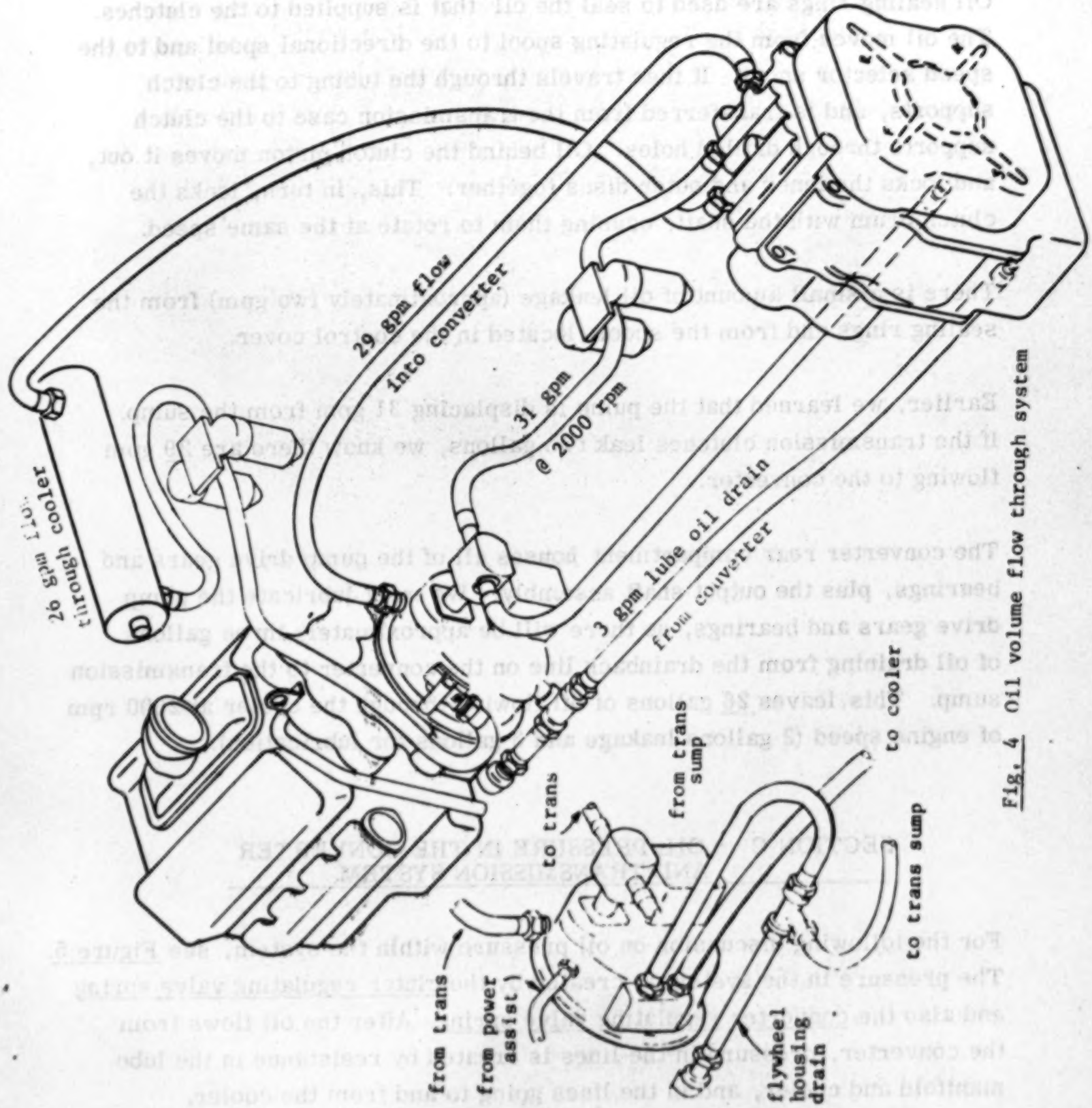

Fig. 4 Oil volume flow through system

valve to the clutches.

Oil sealing rings are used to seal the oil that is supplied to the clutches. The oil moves from the regulating spool to the directional spool and to the speed selector spool. It then travels through the tubing to the clutch supports, and is transferred from the transmission case to the clutch supports through drilled holes. Oil behind the clutch piston moves it out, and locks the inner and outer discs together. This, in turn, locks the clutch drum with the shaft, causing them to rotate at the same speed.

There is a small amount of oil leakage (approximately two gpm) from the sealing rings and from the spools located in the control cover.

Earlier, we learned that the pump is displacing 31 gpm from the sump. If the transmission clutches leak two gallons, we know there are 29 gpm flowing to the converter.

The converter rear compartment houses all of the pump drive gears and bearings, plus the output shaft assembly. We must lubricate the pump drive gears and bearings, so there will be approximately three gallons of oil draining from the drainback line on the converter to the transmission sump. This, leaves 26 gallons of oil flowing through the cooler at 2000 rpm of engine speed (2 gallons leakage and 3 gallons for lubrication).

SECTION C -- OIL PRESSURE IN THE CONVERTER AND TRANSMISSION SYSTEM

For the following discussion on oil pressure within the system, see Figure 5. The pressure in the system is created by the clutch regulating valve spring and also the converter regulating valve spring. After the oil flows from the converter, pressure in the lines is created by resistance in the lube manifold and cooler, and in the lines going to and from the cooler.

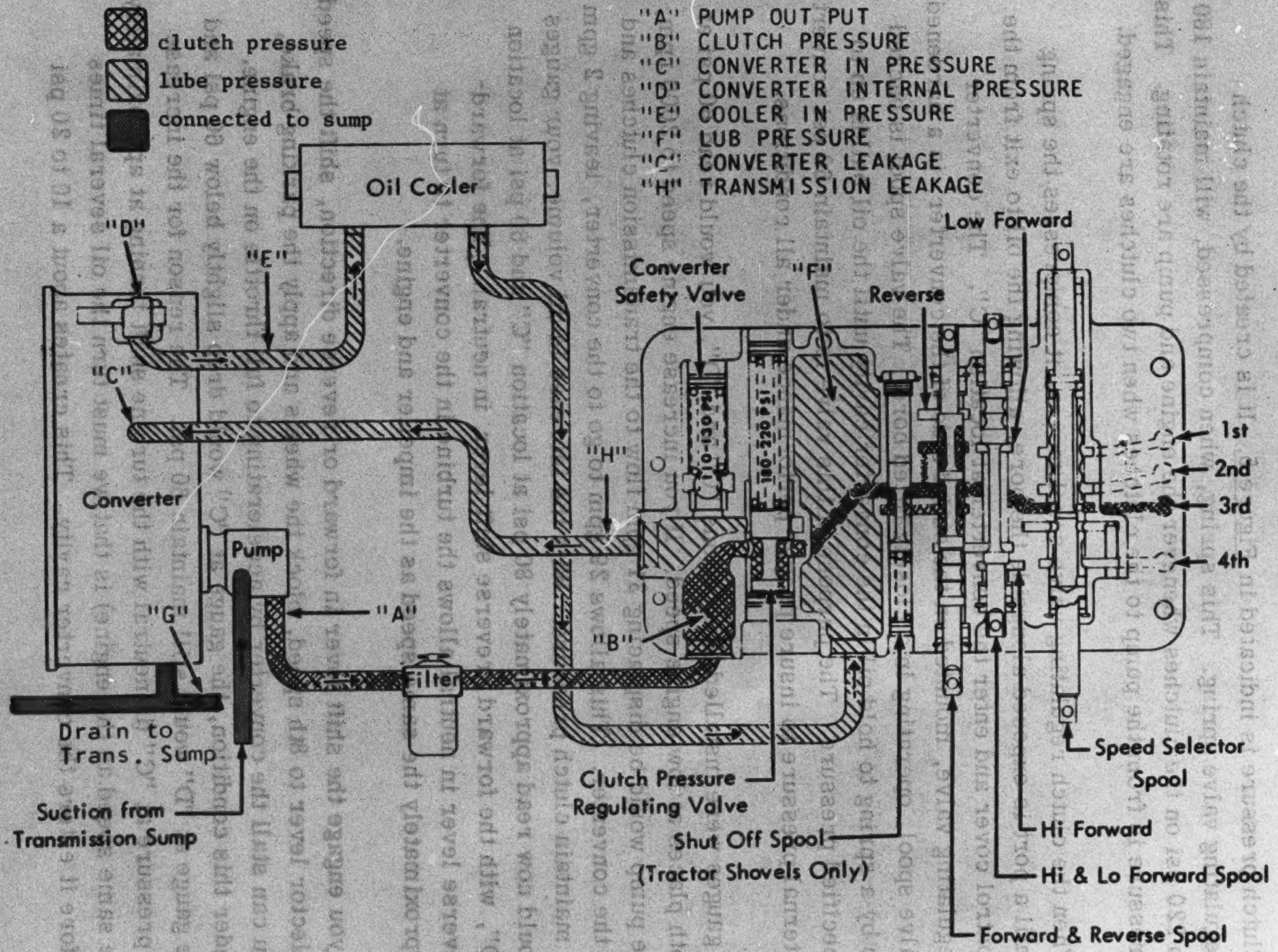

Fig. 5 Oil pressure throughout system

Clutch pressure is indicated in Figure 5. It is created by the clutch regulating valve spring. This spring, when compressed, will maintain 180 to 220 psi on the clutches whenever the engine and pump are rotating. This pressure is from the pump to the clutches when two clutches are engaged.

When the clutch regulating valve spool moves, it compresses the spring until a port is exposed alongside the bore, allowing the oil to exit from the control cover and enter the converter at location "C". The converter regulating valve, mounted on the outlet side of the converter, is a hardened valve spool, operating in a closely fitted bore. The valve spool is backed up by a spring to hold oil in the converter cavity until the oil builds up to specified pressure. The purpose of this valve is to maintain 60 psi converter internal pressure to insure proper performance under all conditions.

If gauges were installed at locations "C" and "D", you would read 60 psi at both places at low engine speed. If you increase engine speed to 2000 rpm, the pump would be displacing 31 gpm flow to the transmission clutches and to the converter. This allows 29 gpm to go to the converter, leaving 2 gpm to maintain clutch pressure. With the increase in oil volume, your gauges would now read approximately 80 psi at location "C" and 60 psi at location "D", with the forward -reverse shift lever in neutral. The forward-reverse lever in neutral allows the turbine in the converter to turn at approximately the same speed as the impeller and engine.

If you engage the shift lever in forward or reverse direction, shift the speed selector lever to 8th speed, block the wheels and apply the parking brake, you can stall the converter by accelerating to full throttle on the engine. Under this condition, the gauge at "C" would drop slightly below 60 psi and the gauge at "D" would still maintain 60 psi. The reason for the increase in pressure at "C" (in neutral with the turbine shaft turning at approximately the same speed as the engine) is that we must turn the oil several times before it enters the converter cavity. This creates about a 10 to 20 psi

differential between "converter in" pressure and converter internal pressure. The reason for the pressure drop at location "C" under stall condition is that the turbine member is stopped and the pump is pumping its greatest oil volume against the turbine member, trying to make it turn and drive the wheels.

The pump (sometimes referred to as the impeller) reacts as follows during converter stall. When the oil leaves the reaction member to enter the pump, this oil volume goes across the inlet port of the converter, causing a slight drop in converter pressure. (This happens under a full stall condition.)

CONVERTER STALL -- Converter stall occurs whenever the turbine and output shaft are stationary and the engine is operating at full power or wide-open throttle.

NOTE: Converter stall must not be maintained for more than 30 seconds at a time, because excessive heat will be generated which can cause converter or transmission seal damage.

After oil exits from the converter, it flows directly to the cooler. From the cooler, it flows to the transmission control valve and enters at location "F". See Figure 5. At location "F", there is a lube manifold which directs the oil down through a series of tubes, lubricating the bearings and clutches inside the transmission case. All bearings are pressure lubricated except the bearings on the output shaft. Those bearings are submerged in oil.

The oil, coming out of the converter, flows to the cooler and then to the lube manifold, and enters the tubing inside the transmission case. The oil flowing through this tubing creates a small amount of pressure at location "F". If a gauge were installed at location "F", you would get a pressure reading of about 5 to 15 psi at 2000 rpm of the pump and engine.

The oil lines to and from the cooler will create about 5 to 10 psi pressure, or resistance, in the system if you have about 26 gpm oil flow from the converter.

The oil coolers have baffle plates built inside to disperse the oil. This is so that the water will sufficiently cool the oil. This means that as oil flows through the cooler, there will be some resistance created. There will be a pressure drop across the cooler of 10 psi normal and 30 psi maximum. If a gauge were installed at location "E" (see Figure 5) and also at location "F", the following approximate readings would be shown at 2000 rpm engine speed.

Pressure readings at "F" would be about 5 to 15 psi, and at location "E" approximately 28 psi with oil at at operating temperature. Pressure at location "E" is the pressure created by resistance to the volume of oil flowing through the lines, the cooler, and the tubing that feeds oil to the bearings and clutch discs.

"A" PUMP OUT PUT
"B" CLUTCH PRESSURE
"C" CONVERTER IN PRESSURE
"D" CONVERTER INTERNAL PRESSURE
"E" COOLER IN PRESSURE
"F" LUB PRESSURE
"G" CONVERTER LEAKAGE
"H" TRANSMISSION LEAKAGE

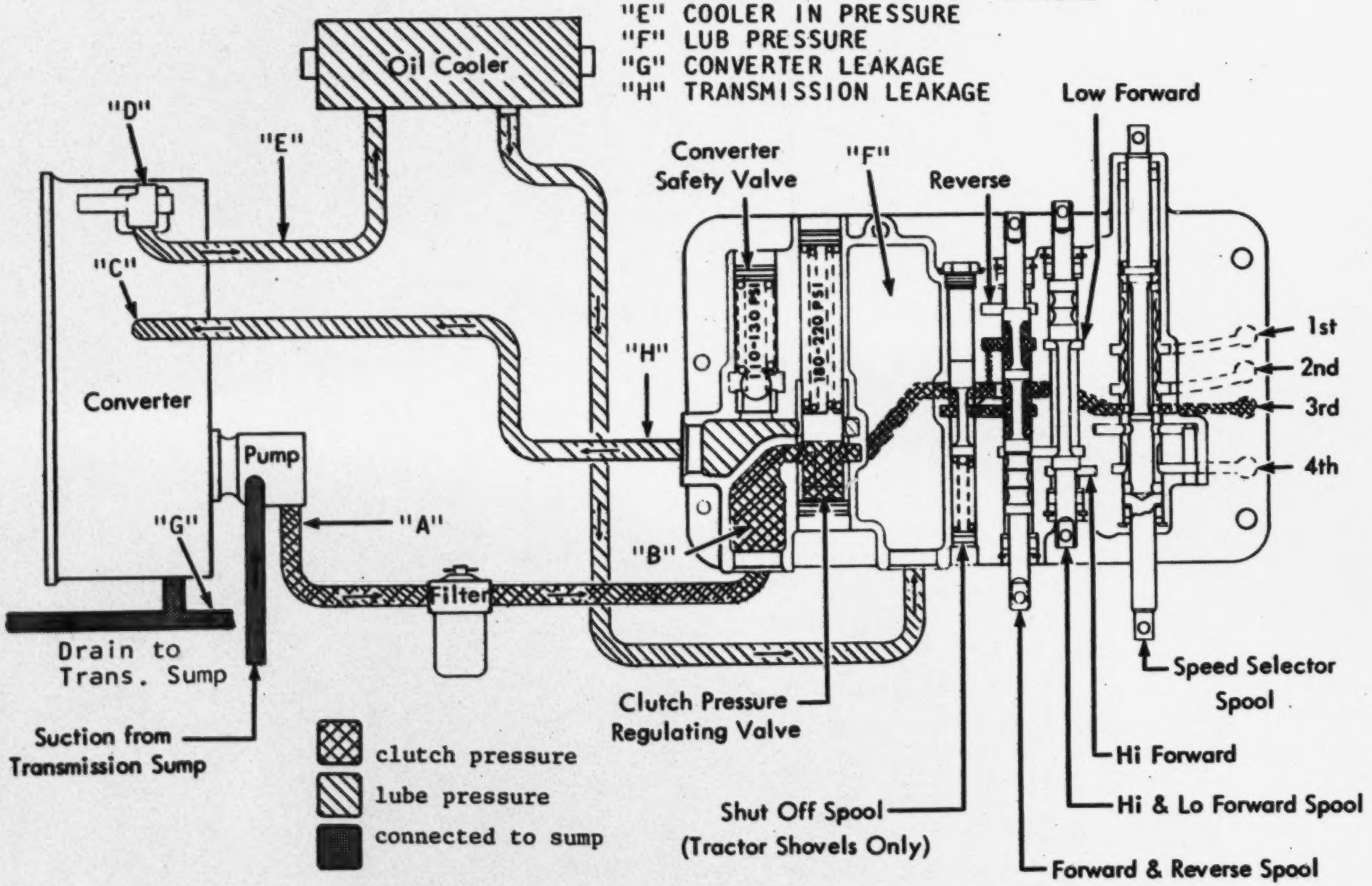

Plate 1 -- Transmission control internal oil flow

DIDACTOR

1

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UNDERSTANDING THE MICHIGAN/CLARK
POWER TRAIN

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Press A 2

Check to see that timer and index are OFF.

1-1

2

This film lesson is the first in a series of several covering the Michigan/Clark transmission. Some of the material presented here has been covered in the class text. There will be questions and answers as in the other home study units. Read carefully and take your time in answering the questions.

Press A 3

1-2

3

Most torque converters used in conjunction with automatic transmissions accept ___(1)___ energy, convert it to ___(2)___ energy and deliver ___(3)___ to the transmission.

A. (1) rotating mechanical (2) mechanical (3) hydraulic force 4

B. (1) mechanical action (2) pneumatic (3) mechanical force 4

C. (1) rotating mechanical (2) hydraulic (3) mechanical torque 5

1-3

4

No. The correct answer is, the converter accepts mechanical (twisting) force from the engine flywheel, converts it to hydraulic energy, then converts it back to mechanical (twisting) force.

Press A 5

1-4

5

You are correct. Through oil turbulence, blades and rotation, the Michigan/Clark converter is able to triple the twisting torque coming from the engine.

Although Michigan/Clark identifies the converter components a little differently than Allison does, it is still necessary that the supply oil pumps be driven by the _____ member.

A. driven 6
B. reaction 7
C. drive 8

1-5

6

No. The supply pumps would never turn if they were connected to the driven member. No oil would be flowing to the converter because the driven member would not be turning. Try this question again.

Press A 5

1-6

7

No. In the Michigan/Clark transmission, the reaction member is stationary; it never moves. Therefore, it could not drive the supply pumps. Try this question again.

Press A 5

1-7

8

You are correct. The drive member always turns at the same rpm as the engine crankshaft. It is through this member (gearing) that the supply pumps are driven.

One thing that connects the drive member to the driven member and makes each one turn is _____.

A. a splined shaft 9
B. oil 10
C. the outer shell 9

1-8

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9

No. The correct answer is oil. Any mechanical connection between the drive member and the driven member would defeat the purpose of the whole system. Twisting torque leaving the engine would not be changed when it entered the transmission.

Press A 10

1-9

10

Correct. Oil is the only connection between the driven member and the driving member.

The Michigan/Clark unit is a constant mesh power shift transmission. It consists of six shafts which enable the operator to have eight speeds forward and four reverse speeds. In the transmission pan there is a screen for eliminating any foreign material that might try to enter the system. Also, there are magnets which collect any metal particles.

Press A 13

1-10

13

The transmission supply pump delivers __(1)__ gpm of oil when the engine is running at __(2)__ rpm.

A. (1) 29 (2) 700 14
B. (1) 26 (2) 2000 14
C. (1) 31 (2) 2000 15

1-13

14

No. The correct answer is that the pump delivers 31 gpm when the engine is running at 2000 rpm. More will be said about pump volume later.

Press A 15

1-11

15

Correct. We will cover more about pump volume and where the oil flows from the pump later.

The charging pump mounted on the converter housing draws oil from the sump located in the _____.

A. converter 16
B. transmission 17
C. engine 16

1-15

16

No. The correct answer is the transmission. Although the converter is separated from the transmission (unlike the Allison) one sump provides oil for both the converter and transmission.

Press A 17

1-16

17

Correct. One sump in the transmission provides oil for both the converter and transmission lubrication.

The purpose of the regulating valve located in the transmission control cover is to _____.

A. allow oil to flow to the converter first 18
B. allow oil to flow to the clutches first 20
C. act as a safety valve for the system 19

1-17

18

No. Oil flows to activate the transmission clutches first. After they are satisfied, the regulating valve opens and oil is allowed to flow into the converter.

Press A 20

1-18

19

No. We haven't mentioned the safety valve yet. Think about the name of this valve (regulating) and then try this question again.

Press A 17

1-19

20

Correct. Oil is supplied to the clutches first; once these are satisfied, oil is then allowed to flow into the converter.

After leaving the converter, oil is directed to the _____.

A. clutch pressure regulating valve 21
B. oil cooler 22
C. oil distributor 21

1-20

21

No. After leaving the converter, oil flows through the oil cooler and then back to the transmission for lubricating purposes.

Press A 23

1-21

22

Correct. After the oil leaves the converter it flows into the oil cooler. After leaving the cooler, the oil is directed through a hose to the lubricating oil inlet on the transmission, then through a series of tubes to the transmission, bearings and clutches. The oil then returns to the sump.

Press A 24

X(C)-23

1-22

23

The answer to the previous question is: oil flows from the converter to the oil cooler.

You have missed one or two of the questions in this sequence of material. Review this information again and take your time in answering the questions.

Press A 2

1-23

24

If only 26 gpm (from an original total of 31 gpm) flow from the converter to the oil cooler, the remainder _____.

A. leaks through the clutch seals 25
B. lubricates the pump gearing 25
C. Both A and B are correct 26

2-21

25

You are only partially correct. Of the remaining 5 gpm, 2 gpm leak past the clutch seals and 3 gpm lubricate the supply pump gearing.

Press A 26

2-25

26

OK.

Two gpm of oil leak around the clutch seals. The other 3 gpm, after being used for gear pump lubrication, drain back to the sump -- leaving 26 gpm flowing to the cooler.

Press A 27

2-26

4

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27

The amount of pressure that is maintained on the clutch packs is _____ psi at 2000 rpm engine speed.

A. 60 to 80 28
B. 90 to 120 28
C. 180 to 220 29

2-27

28

No. The correct answer is 180 to 220 psi. This pressure is maintained by the clutch regulating valve spring.

Press A 29

2-28

29

Correct. This pressure is maintained by the clutch regulating valve spring whenever the engine and pump are rotating.

Another spool type valve, located in the converter housing and called the converter regulating valve, maintains _____ psi of pressure within the converter housing.

A. 120 30
B. 60 31
C. 40 30

2-29

30

No. The converter regulating valve maintains only 60 psi oil pressure within the converter.

Press A 31

2-30

31

Correct. The purpose of this valve is to maintain 60 psi converter internal pressure to insure proper performance under all conditions.

Looking at Plate I, if gauges were installed at "C" and "D" locations, a reading of 60 psi would be indicated at low engine rpm. At high engine rpm the reading at "D" location would be _____ psi.

A. 60 33
B. 80 32
C. 180 32

2-31

32

No. Remember we said the converter regulating valve maintains 60 psi under all conditions.

If the engine rpm is increased, the reading at "C" (input to the converter) would read approximately 80 psi, but the reading at "D" would remain the same.

Press A 33

2-32

33

Correct. The converter regulating valve spring maintains 60 psi under all conditions (low engine speed or high engine speed). At high engine speed and with the forward and reverse lever in neutral, the reading at "C" location (converter input) would be approximately 80 psi.

When the converter is in a "stall" condition, it means there is _____.

A. little or no oil moving in the converter 34
B. violent swirling and churning of oil 35
C. Neither A nor B is correct 34

2-33

34

No. If you chose "there is little or no oil moving in the converter" or "neither A nor B is correct," you are wrong. The correct answer is that there is violent swirling and churning of oil in the converter. Let's see why.

Press A 35

2-34

35

OK. When the converter is in a stall condition, the turbine is stopped but the pump is turning at maximum rpm, which creates much oil turbulence between the two members.

Should this converter stall condition be allowed to continue, which of the following do you think would happen?

A. The turbine would be forced to move. 36
B. The supply pump would drain the sump. 37
C. The oil cooler would be inadequate. 38

2-35

36

No. Usually in a stall condition, the vehicle wheels are blocked, preventing any movement. If the wheels (and consequently the drive lines and transmission) cannot rotate, then the turbine cannot move. Think about this condition and try the question again.

Press A 35

2-36

37

Your answer would be right if the stall continues long enough to burn up the seals and cause excessive leaking of oil. You have the right idea, there would be a tremendous heat build-up. Let's see why.

Press A 38

2-37

38

OK. With oil being thrown against the turbine by the pump and the turbine not moving, the heat build-up would be tremendous and the cooler would not be able to handle it. This is why the manufacturer insists that stall should not be continued for more than 30 seconds.

Press A 39

2-38

39

After oil exits from the cooler it is directed to the transmission control valve at "F" location, see Plate I. At "F" is a lube manifold which directs oil through a series of tubes, lubricating the bearings and clutches inside the transmission.

within the transmission enclosure are pressure lubricated.

A. All bearings and gears 40
B. All bearings and gears except the output shaft and bearings 41
C. Only the output shaft and bearings 40

2-39

40

No. All the bearings except the output shaft and bearings are pressure lubricated. The oil level (sump) is high enough within the case so that the output shaft and bearings are lubricated by submersion.

Press A 41

2-40

41

OK. All bearings except the output shaft and associated bearings are pressure lubricated.

The reason a resistance is created when oil flows through the cooler is that the oil _____.

A. has more area to fill in the cooler 42
B. has to be compressed into a smaller area when it leaves the cooler 42
C. is forced to follow many different paths while in the cooler 43

2-41

42

No. You are not correct.

The cooler contains numerous baffles which force the oil to travel in and out and around. This causes resistance in the line.

The resistance causes a pressure drop of 10 psi normal and 30 psi maximum.

Press A 43

2-42

43

OK. Resistance in the line causes a pressure drop of 10 psi (normal) to 30 psi (maximum).

A CLOSER LOOK AT THE CONVERTER -- As you recall in our discussion of the Allison transmission, all parts within the converter rotated, even though some only in one direction. We know this is not true in the Michigan/Clark transmission.

Which of the following does not move?

A. Drive disk 44
B. Reaction member 45
C. Neither A nor B is correct 44

2-43

44

No.
The one that does not move is the reaction member. This is splined on a fixed support within the converter housing.

Press A 45

2-44

45

OK. The reaction member (stator) is fixed in the Michigan/Clark transmission.

Several precautions must be observed when installing the converter to the engine. Which one of the following is not critical?

A. Tight drive gears 46
B. Converter pilot and flywheel bore 46
C. Neither A nor B is the answer 47

2-45

46

No. If you chose "tight drive gears" or "converter pilot and flywheel bore," you are incorrect. Both of these items are critical during preassembly.

Press A 47

2-46

47

Correct. Tight drive gears can result in engine failure if the converter has not been installed correctly. Also the converter pilot and flywheel bore must be checked for proper clearance. The converter pilot must be a slip fit into the engine flywheel bore (.001 is minimum clearance).

Press A 48

X(c)-48

3-47

48

OK. Neither A nor B were correct.

You have missed one or more questions in this sequence of material and should have the opportunity for review. Read the questions carefully and take your time in selecting an answer.

Press A 24

2-48

49

TRANSMISSION FUNCTION -- The Michigan Clark transmission being discussed has eight speeds forward and four speeds reverse.

Theoretically, it can be divided into two parts, an upper half, (forward and reverse shafts and clutches), and a lower half (speed section).

In this transmission the idler shaft also serves as the input shaft. This is a _____ statement.

A. true 50
B. false 51

3-49

50

No. The idler shaft is not the same as the input shaft. The idler shaft is between the upper half and lower half of the transmission and serves to transmit power in the selected direction to the speed section.

Press A 67

3-50

51

OK. That statement is false. The idler shaft serves only to transmit power in the selected direction to the speed section.

Power is received into the speed section from _____ of the idler shaft.

A. both ends 53
B. one end 52
C. neither end 52

3-51

52

No. Both ends of the idler shaft do transmit power to the speed section.

Press A 53

3-52

53

OK.
Remembering our session on gears, if the first or second clutch is applied, power is transmitted from the idler pinion gear on the forward end of the idler shaft to a _____ gear on the clutch drum.

A. small 54
B. medium 54
C. large 55

3-33

54

No. If you chose small or medium you are incorrect. Remember in first or low gear maximum torque is required. To obtain this, we need a small gear driving a large gear.

Press A 55

3-31

55 58

OK. The drive gear must be the smaller of the two in order to obtain the desired torque through the transmission.

Power from the drive gear passes through the clutch to the shaft and through the final gears to the output. The ratio between first and second is obtained by the difference in the final output drive ratios.

Press A 56

3-35

56

Third and fourth gears are similarly obtained, except that their respective clutches are driven by the large gear on the rear end of the idler shaft. The drive to the output shaft is through the same gears used for first and second speeds.

In the Allison transmission there had to be two clutches engaged before power could be transmitted to the rear wheels. In the Michigan/Clark transmission _____ to be engaged to accomplish the same thing.

A. three clutches have 57
B. two clutches have 58
C. one clutch has 57

3-36

57

No. If you chose one or three, you are incorrect. Two clutch packs have to be engaged in order to get the vehicle moving.

Press A 58

3-37

58

OK. Two clutch packs must be engaged to move the vehicle.

Both the Allison and certain Michigan/Clark transmissions _____.

A. are easy to work on 59
B. have interchangeability of parts 61
C. use the planetary gear principle 60

3-38

59

Not quite. Most authorities say the Allison, having the converter and gear box all in one case, is much more difficult to work on. The Michigan/Clark on the other hand, since the two components are separated, makes it easier to work on one or the other without disassembling both. Try this question again. Press A 58

3-59

60

No. The Michigan/Clark transmission does not use the planetary gear principle in the transmission (although this principle may be used on the wheels of certain vehicles).

Remember that the Michigan/Clark is a constant mesh gear type transmission.

Press A to try the question again. 58

3-60

61

Correct. Both transmission manufacturers boast interchangeability of parts. In addition, since the Michigan/Clark separates the converter from the gear box, they claim much easier maintenance.

Press A 62

3-61

62

There are two adjustments that must be made in the reassembly of the Michigan/Clark transmission. Which of the following is not one of these adjustments.

A. Shim the output shaft bearings. 63
B. Shim the idler shaft bearings. 63
C. Tighten input shaft nuts to 500 lb-ft. 64

3-62

63

No. If you said "shim the output shaft" or "idler shaft bearings," you are incorrect. These two adjustments must be made during reassembly of the transmission.

Press A 64

3-63

64

OK. Tightening the input shaft nuts is an assembly procedure, not an adjustment procedure.

Also, the lb-ft torque required to tighten these nuts is different on different models of transmissions, Check the appropriate manual for these specifications.

Press A 65

3-64

65

The internal tubing, mounted inside the transmission case, directs oil to _____.

A. activate the clutches ~~XX~~ 67
B. lubricate the bearings and shafts 66
C. Both A and B are correct XX

3-65

66

You are only partly correct. The oil which has been directed by the tubing in the transmission case does two things:

1. It activates the clutches
2. It lubricates the bearings and shafts

Press A 67

3-66

67

OK. The lines direct oil to the clutches and to the bearings.

Remember, it is very important to block the gears in place when removing shafts from the transmission, so that the oil lines will not be damaged.

Press A 68

3-67

68

MANUAL SHIFT CONTROL VALVE -- The control valve body on the transmission case consists of three spool valves controlled from the operator's cab.

The multiple combinations of speeds are obtained by using the speed selector spool (four position), the HI-LO spool (two position), and the FORWARD-REVERSE spool (two position).

Press A 70

3-68

70

In the text, we spoke of a detent ball. You will recall from valve discussions in the past that this _____.

A. is a device that retards oil leaks 71
B. prevents the spools from being forced from the cover 71
C. holds the spool in the different positions 72

3-70

71

No. If you said a detent ball is a device that retards oil leaks, or that it prevents the spools from being forced from the case, you are incorrect.

The purpose of a detent ball, of which there may be more than one in the valve, is to retain the spool in the various positions within the valve.

Press A 72

3-71

72

OK. Usually these metal detent balls are spring loaded and ride up and down the valleys of the spool, holding the spool in place when it reaches the farthest point of travel (in the valley).

MAINTAINING THE TRANSMISSION -- Preventive maintenance, regular inspections, and the use of the right oils are very important in prolonging the life of a Michigan/Clark transmission (or any transmission for that matter).

Press A 73 X(c)-72A 4-72

72.1

OK.
These metal balls are usually spring loaded and ride up and down in the valleys of the spool. They hold the spool in place when it reaches the farthest point of travel (in the valley).

You have missed one or more questions in this sequence of material and should have the opportunity to review. Read the questions carefully and take your time in selecting your answers.

Press A 49

3-72A

73

RULES TO REMEMBER:

1. Change oil filter every 250 hours of operation
2. Change oil every 500 hours of operation

When draining the converter, it is important that all parts of the system be emptied of oil. Drain the converter oil cooler and filter as well as the sump. Some units provide drain plugs in the converter impeller. Remove these plugs and rotate the converter so that one hole is at the bottom. This allows the oil inside the elements to drain.

Press A 74

4-73

74

Another important item to remember when servicing the oil system is DO NOT USE FLUSHING OIL. Some units cannot be completely drained and a considerable amount of oil remains trapped in the converter elements. Entrapped flushing oil will contaminate the refill.

When REFILLING, cleanliness is extremely important. (Clean storage containers are VITAL.) Fill the sump to the full mark on the dipstick. Start and operate the converter at slow speed and continue filling until oil remains at the full mark.

Converter oil level is always measured with the converter in operation at engine idle. Press A 75

4-74

75

Inspection of oil should be made at the end of every shift. Always clean around inspection plug before inspection. Add sufficient oil to maintain correct oil level.

When draining the oil system, you should remember to _____.

A. start and run converter at a slow speed 76
B. use a good grade of flushing oil 76
C. check dipstick to be sure all oil has drained 76
D. avoid all three practices listed above 77

4-75

76

No! All three practices listed should be avoided when draining the oil system.

1. Do not operate the converter when draining.
2. Do not depend on dipstick readings to assure thorough discharge.
3. Never use flushing oil.

Let's review briefly. These rules are important.

Press A 73

4-76

77

You are right. None of the three statements are correct procedure when draining a Michigan/Clark power shift transmission oil system.

The satisfactory performance of Michigan/Clark converter units depends largely on the use of a high quality torque converter oil. The oil:

1. must remain fluid at all temperatures
2. must not foam excessively nor increase in volume
3. must be chemically stable at elevated temperatures
4. must be free from additives and impurities which would centrifuge (separate) out during operation
5. must be CLEAN

Press A 78

4-77

78

Now, let's review some of the important points we have learned about the Michigan/Clark transmission.

There are __(1)__ shafts in the transmission being discussed, two of which need bearing adjustments upon reassembly. These two are called __(2)__ and __(3)__.

A. (1) four (2) output (3) input 79
B. (1) six (2) idler (3) output 80
C. (1) six (2) idler (3) input 79

4-78

79

No. There are six shafts, two of which need adjustments during reassembly. These two are the idler and output shaft.

Press A 80

4-79

80

OK.
The converter regulating valve maintains a __(1)__ psi rating, while the converter safety valve maintains a __(2)__ psi rating.

A. (1) 80 (2) 80 to 110 81
B. (1) 60 (2) 110 to 130 82
C. (1) 45 (2) 180 to 220 81

4-80

81

No. The converter regulating valve maintains a 60 psi rating, while the converter safety valve maintains a 110 to 130 psi rating.

Press A 82

4-81

82

OK.
During disassembly, it is very important to _____ the gears before removing the shafts from the gear box.

A. remove 83
B. block 84
C. grease 83

4-82

83

No. The correct answer to the last question is: block the gears before removing the shafts. This prevents damage to the tubing.

Press A 84

4-83

84

Correct.

Congratulations, you have completed this initial film lesson on the Michigan/Clark transmission.

Press REWIND. X(c)-85

4-84

85

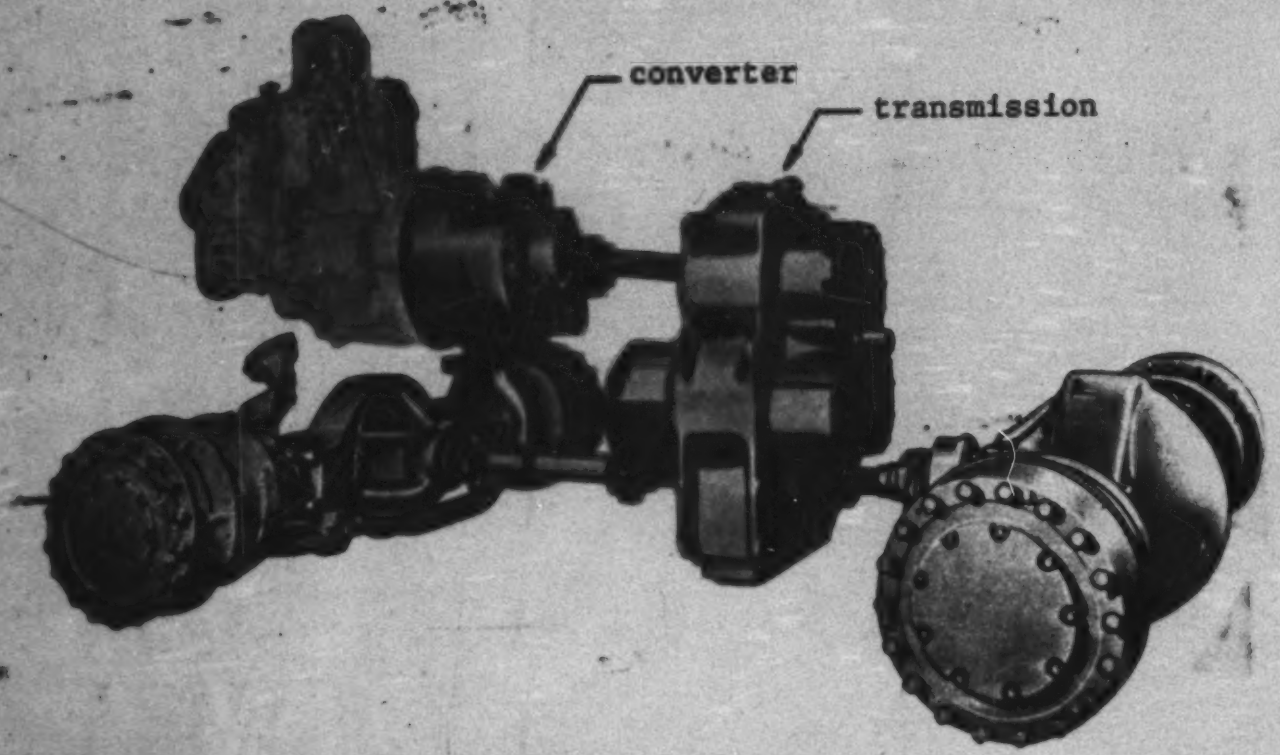
The answer to the last question is: the gears must be blocked when removing the shafts to prevent damaging the internal tubing.

You have missed one or more of the questions in this sequence of material and should be given the chance for a review. Read the last few frames again and take your time in answering the questions.

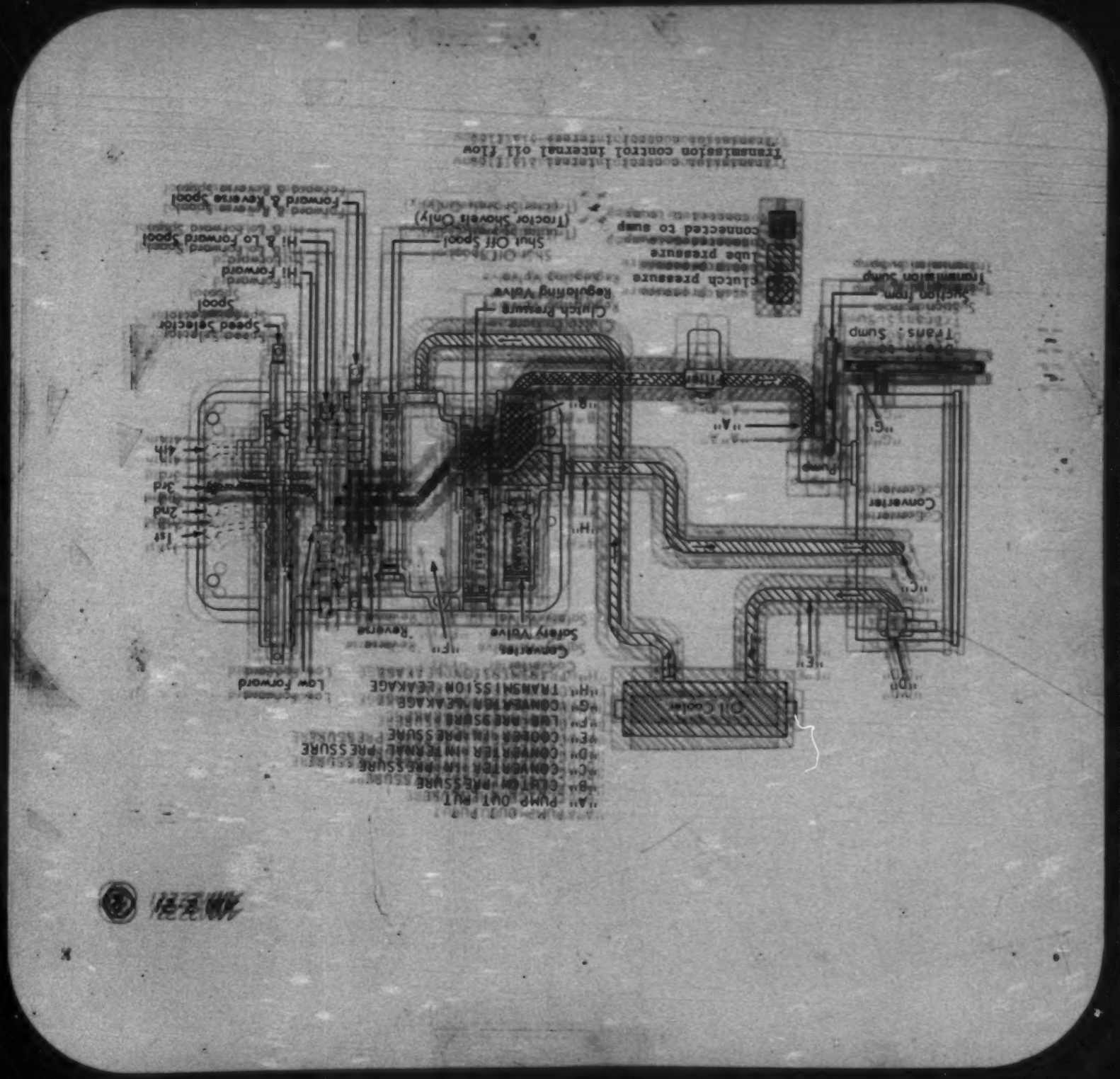
Press A 73

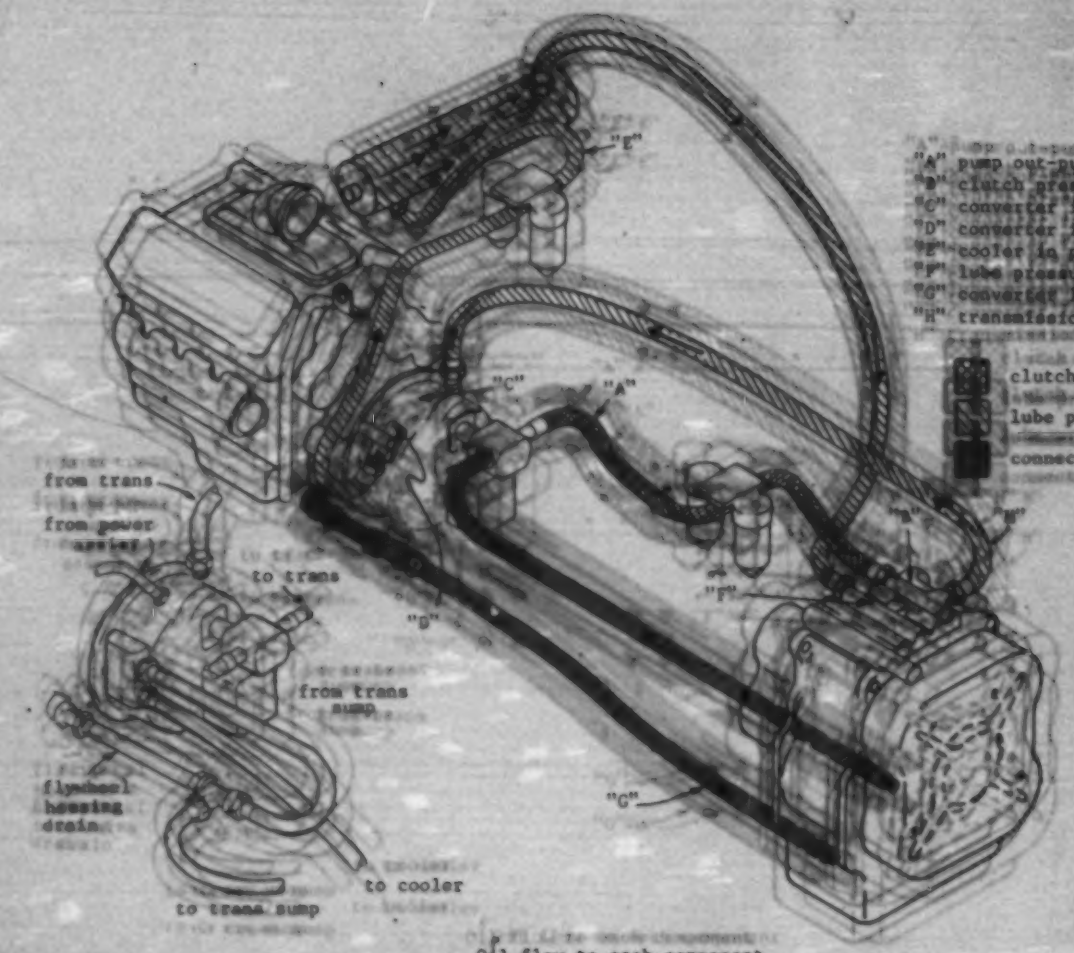
4-85

AM 2-21



Tractor dozer power train components

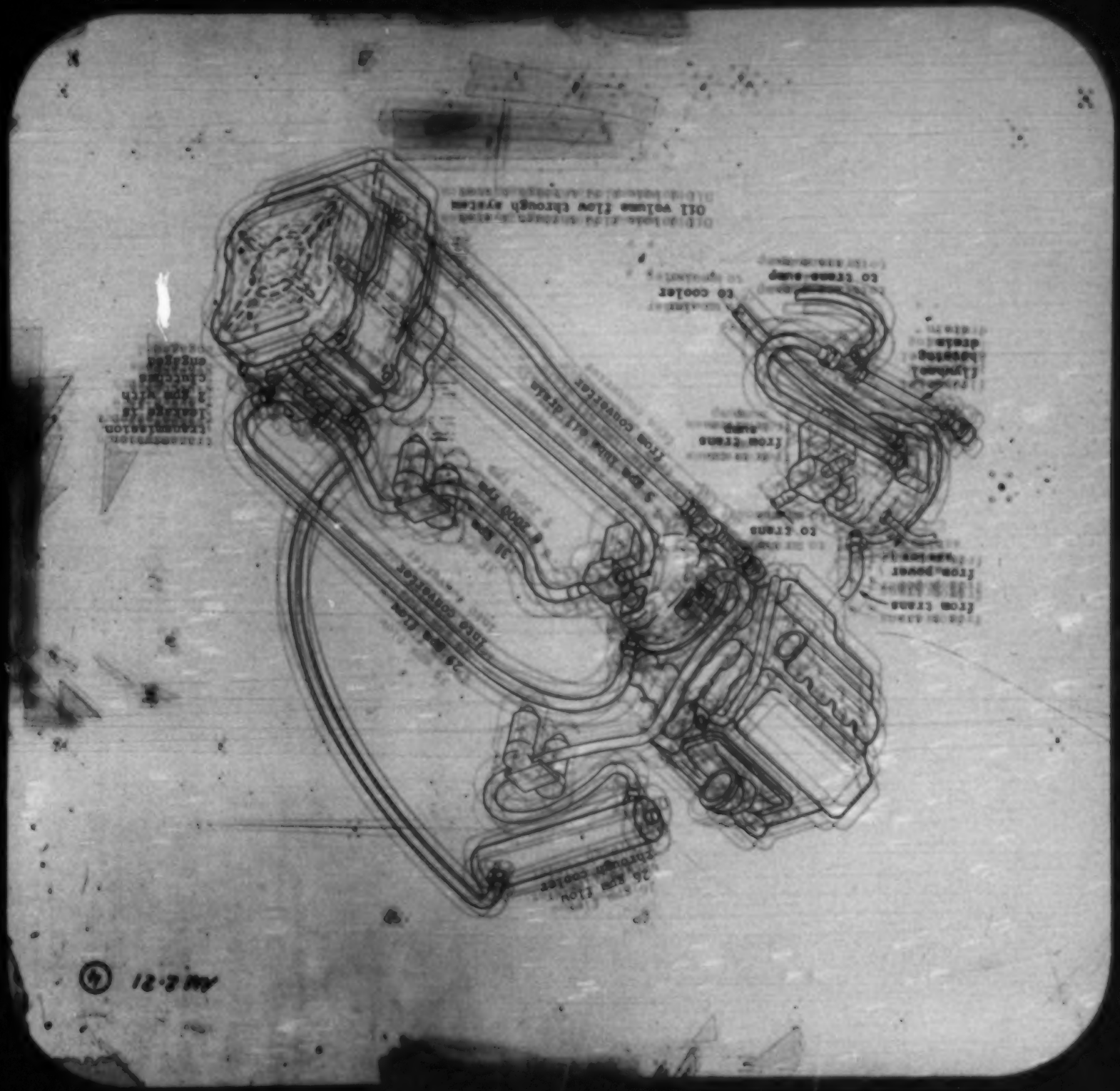

Transmission control internal oil flow
"A" PUMP OUT PUT
"B" CLUTCH PRESSURE
"C" CONVERTER IN PRESSURE
"D" CONVERTER IN TEXNAL PRESSURE
"E" COOLER IN PRESSURE
"F" LUBRE PRESSURE
"G" CONVERTER OUTLET
"H" TRANSMISSION LEAKAGE
Low Forward
Converter Safety Valve
Reverse
1st
2nd
3rd
4th
Speed Selector Spool
Hi Forward
Hi & Lo Forward Spool
Shut Off Spool (Tractor Shovels Only)
Forward & Reverse Spool
Clutch Pressure Regulating Valve
Clutch pressure
Lube pressure
connected to sump
Trans. Sump
Suction from Transmission Sump
Filter
Pump
Converter
Oil Cooler



"A" pump out-put
"B" clutch pressure
"C" converter in pressure
"D" converter internal pressure
"E" cooler in pressure
"F" lube pressure
"G" converter leakage
"H" transmission feed

clutch pressure
lube pressure
connected to sump

Oil flow to each component


OCI volume flow through system
To cooler
To trans-amp
From trans amp
To trans
From power
From trans
To OCI
From converter
To converter
To cooler

INSTRUCTOR'S GUIDE

Title of Unit: MICHIGAN/CLARK TRANSMISSION -- COMPLETE POWER TRAIN

AM 2-21
9/22/67

OBJECTIVES:

1. To present an introduction to the Michigan/Clark off-highway power train.
2. To discuss briefly each system and component of the Michigan/Clark transmission assembly.

LEARNING AIDS (suggested)

VU CELLS:

AM 2-21 (1) Complete power train
AM 2-21 (2) Transmission control internal oil flow
AM 2-21 (3) Oil flow to each component
AM 2-21 (4) Oil volume flow through system

MODELS:

Arrangements can be made to have a working model of a Michigan/Clark transmission at your center. Tear-down and assembly on a class participation basis would be excellent for teaching purposes during these discussions.

QUESTIONS DESIGNED FOR CLASS DISCUSSION:

1. What is meant by multiplication ratio?
2. What is the multiplication ratio differential in the Michigan/Clark torque converter?
3. How many speeds forward and reverse does this transmission have?
4. How does this arrangement differ from the Allison transmission?
5. What types of energy does any converter transform? Explain.
6. How many components are there in this converter? How many rotate individually?
7. What is meant by the reaction member?
8. Does the reaction member rotate?

9. What drives the oil pump in this arrangement?
10. What is the correct name for this type of transmission?
11. How many shafts are there in this transmission?
12. How and when should the oil be checked in the transmission?
13. Approximately how many gallons of oil flow through the cooler per minute? Why not 31?
14. When does the pump draw 31 gallons of oil from the sump?
15. How many cartridge type filters are included in this system?
16. What two components regulate pressure in this system? What are these pressures?
17. What occurs in a "converter stall" situation?